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Undergraduates' Statistics Anxiety: A Phenomenological Study

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Abstract

In this phenomenological study, students' perceptions of statistics anxiety were explored, as were the factors that they believe contribute to and reduce their statistics anxiety. The participants were undergraduates enrolled in an introductory statistics course at a Rocky Mountain region mid-sized university. Six students participated in this study. A modified version of the Mathematics Attitudes Scale was used to measure students' statistics anxiety scores. Students with higher statistics anxiety scores on the surveys were interviewed. The interview data were analyzed using thematic analysis. The results revealed that undergraduates from a non-mathematics background, having high statistics anxiety, feel challenged while in statistics class, solving statistical problem, taking tests, or speaking in front of their peers. These challenges were found to be due to their inability to process statistical language, which gave rise to feelings of inadequacy, and manifested as physiological symptoms. All these factors led students to give up or second guess answers on tests. These students thus ended up performing poorly. Finally, these undergraduates noted that having open notes and formula sheets during tests alleviated their statistics anxiety. Teachers need to know their students' challenges and address them so that students with aboveaverage statistics anxiety levels feel included and understood

Keywords

Statistics Anxiety, Undergraduate Students, Phenomenology, Thematic Analysis, Qualitative Research, Statistics Education.

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Undergraduates' Statistics Anxiety: A Phenomenological Study

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In this phenomenological study, students' perceptions of statistics anxiety were explored, as were the factors that they believe contribute to and reduce their statistics anxiety. The participants were undergraduates enrolled in an introductory statistics course at a Rocky Mountain region mid-sized university. Six students participated in this study. A modified version of the Mathematics Attitudes Scale was used to measure students' statistics anxiety scores. Students with higher statistics anxiety scores on the surveys were interviewed. The interview data were analyzed using thematic analysis. The results revealed that undergraduates from a non-mathematics background, having high statistics anxiety, feel challenged while in statistics class, solving statistical problem, taking tests, or speaking in front of their peers. These challenges were found to be due to their inability to process statistical language, which gave rise to feelings of inadequacy, and manifested as physiological symptoms. All these factors led students to give up or second guess answers on tests. These students thus ended up performing poorly. Finally, these undergraduates noted that having open notes and formula sheets during tests alleviated their statistics anxiety. Teachers need to know their students' challenges and address them so that students with above-average statistics anxiety levels feel included and understood. Keywords: Statistics Anxiety, Undergraduate Students, Phenomenology, Thematic Analysis, Qualitative Research, Statistics Education.

Statement of the Problem

Statistics anxiety has been defined as “the feelings of anxiety encountered when taking a statistics course or doing statistical analyses; that is, gathering, processing, and interpret[ing]” (Cruise, Cash, & Bolton, 1985, p. 92). Onwuegbuzie, DaRos, and Ryan (1997) defined it as the anxiety that occurs as a result of encountering statistics in any form and at any time. Researchers have noted statistics anxiety among their students. Several researchers (Blalock, 1987; Dillon, 1982; Onwuegbuzie & Seaman, 1995) have found negative effects of statistics anxiety on students' learning and performance in statistics related courses. Furthermore, Mji (2009) noted that statistics anxiety may negatively affect acquisition of skills, knowledge, and strategies identified as necessary for students' prospective careers. Research therefore indicates that students with statistics anxiety feel challenged in taking statistics courses. This in turn adds to their pressure and perpetuates poor performance.

According to Zeidner (1991), the statistics anxiety levels among students from non-mathematics background may be higher than among those students from mathematics oriented areas. Pan and Tang (2005) noted that students having limited prior statistical or mathematical training may have noticeably higher levels of statistics anxiety. Research indicates that often students with high anxiety may delay enrolling in statistics courses until the end of their academic programs and this adds to the stress of taking these courses (Onwuegbuzie, 1997). Most undergraduates in the social sciences are required to take statistics courses as part of their program of study; therefore, undergraduates' statistics anxiety needs to be addressed.

Researchers have also focused on factors that reduce statistics anxiety. Dillon (1982) demonstrated that students' statistics anxiety can be decreased by encouraging them to talk about their fears, and suggested ways that they can cope with their statistics anxiety. Schacht and Stewart (1991) found that gathering data from the students themselves and having students perform simple calculations (obtaining the mean, etc.) reduces anxiety levels and increases motivation to become involved in the class. Pan and Tang (2005) found that when the instructor was sensitive to students' concerns and used effective instructional strategies, their statistics anxiety was reduced and learning was enhanced.

Research findings signify that it is important to have students share and discuss their experiences about statistics anxiety. While many quantitative studies provide insight into the negative experiences of students with statistics anxiety, as well as the factors that reduce anxiety levels, far too little qualitative research exists on this subject. Finally, limited qualitative research is available on factors and specific situations that lead to negative feelings and experiences of students in statistics classes or on how teachers and educators can address these factors.

Purpose of the Study

The participants were enrolled in an introductory statistics course at a doctorate granting university in the Rocky Mountain region of the United States. Most of the students enrolled in this university are required to take an introductory statistics course as part of their degree. It is imperative that research be conducted to explore these undergraduates' perceptions and thoughts regarding statistics. The purpose of this phenomenological study was to provide an understanding of undergraduate students' experiences and perceptions of statistics anxiety. In particular, this study was intended to identify various factors that undergraduate students believe cause and reduce their statistics anxiety levels.

Research Questions

As mentioned earlier, several researchers have examined the effects of anxiety on other variables in recent years; however, the specific sources have not yet been clearly established. Moreover, few researchers have specifically examined anxiety from the learner's perspective. Although previous studies have pointed to a number of interesting relationships between anxiety and other variables, conclusions have been based on the researchers' personal interpretations of learner statements. Furthermore, statistics anxiety needs to be addressed specifically among students who have limited statistical background. This study therefore involves an exploration of what undergraduates, with limited mathematics or statistics background and above-average statistics anxiety levels experience daily.

This study was conducted to give students with above average statistics anxiety levels a voice by attempting to understand what it is like for them to learn statistics and what they believe are the factors that contribute to and reduce their statistics anxiety. Hence, this paper is an attempt to explore students' learning with anxiety issues in the broader context of statistics education. The data collected were analyzed to answer the following questions:

1. What are the specific situations that trigger intense feelings of statistics anxiety among undergraduates?
2. What factors do undergraduates believe contribute to their heightened levels of statistics anxiety?
3. What factors do undergraduates believe contribute to their reduced levels of statistics anxiety?

Methodology

Theoretical Perspectives

I have based the framework for this study on Crotty's (1998) model. This model involves four elements of social research composing the framework of a research process: (1) epistemology, (2) theoretical perspective, (3) methodology, and (4) methods. Constructivism refers to the belief that people effectively construct the meaning of the reality around them through their interactions with each other and the objects in the environment. Under the guidance of constructivism, interpretivism is the theoretical perspective that framed this study designed to explore students' beliefs about the factors of statistics anxiety. Interpretivism provides a framework to understand and explain human and social reality (Crotty, 1998). I used phenomenology as the research methodology for this study. Phenomenology is generally seen as a study of people's subjective and everyday experiences (Crotty, 1998). The researcher who conducts a phenomenological study seeks to explore the essence or structure of a phenomenon by using data that are participants' firsthand experience of the phenomenon (Yeh & Lehman, 2007). Because this research is about experiences of undergraduates with above-average statistics anxiety levels as they understand it in everyday terms, this methodology is most appropriate (Crotty, 1998). Finally, the method was conducting open-ended, one-on-one, task-based, semi-structured interviews (Merriam, 2009).

Role of the Researcher

I had the primary role of conducting this research. I was the one who administered the surveys in all the selected sections of Introductory Statistics class. I was the only person who analyzed the survey data to find out each student's anxiety score and scheduled interview appointments. I conducted the interviews, transcribed, and performed the analysis of the data. A fellow graduate student reviewed the themes and categories. My project supervisor and my classmates provided an overall peer check (Merriam, 2009). They read and gave valuable suggestions and feedback from time to time during the semester-long process.

Participants

The participants were six undergraduate students, aged 18 and over, enrolled in *Introduction to Statistical Analysis* (STAT 150) as part of their degree requirements at a university in the Rocky Mountain region of the United States. Pseudonyms were assigned to maintain participants' anonymity, Brian, Kathy, Casey, and Jacky were Psychology majors, whereas Mandy was majoring in Nursing. At the time of this study, Natalie was still indecisive about her major. The participants were enrolled in this course during the fall 2011 semester. I used purposeful sampling (Merriam, 2009) to choose the participants, basing my selection on participants' exceptionally high levels of statistics anxiety.

The data for this study were collected first through the administration of a survey to select potential participants and subsequently through the individual interviews. The survey administered to select the participants was a 10-item modified version of one of Fennema and Sherman's (1976) nine Mathematics Attitudes Scales (MAS). I found this modified version in the literature (Gundy et al., 2006). In this manuscript, this modified version is termed as the Students' Statistics Anxiety Scale (henceforth referred to as SSAS). The SSAS is based on a four-point Likert-type scale and has 10 items, measuring only one construct, statistics anxiety. Response choices for the items are (1) strongly disagree, (2) disagree, (3) agree, and (4) strongly agree. In addition to the 10 items, the SSAS survey form also includes

demographic items (such as, gender and major etc.) as well as students' contact information. Items 6 through 10 were reverse coded to reflect their negative wording. Possible scores ranged from 10 to 40. Higher overall survey scores reflect higher levels of statistics anxiety.

The SSAS also included two open-ended questions to provide understanding of the participants' experiences solving statistical problems. The main purpose of these open-ended questions was to determine which students were ready to self-reflect on their feelings of statistics anxiety and share their experiences. This was also useful in reducing the number of students to six participants.

Setting

The classes, from which the participants were selected, met three times a week for 50 minutes during the 16-week of the fall 2011 semester. The textbook used for this course was *Elementary Statistics-A Step by Step Approach* by Allan G. Bluman (2009). Each of the sections was taught at a different time of the day. All the instructors were full-time graduate students (TAs) from the mathematics or the statistics departments. The university where this study was conducted is located in the Rocky Mountain region of the United States. The general population, the study participants students in this university and those students in the statistics classes studied were all predominantly white, with approximately 30% having Hispanic heritage.

Methods

Institutional Review Board approval was obtained prior to the administration of the surveys. All standards for ethical treatment of participants set forth by the American Psychology Association (APA), including obtaining informed consent and maintaining confidentiality, were followed at all times during this study. Students were informed about their rights as human subjects and about the confidentiality of the study before they completed the surveys. They were informed that their participation in the study would be completely voluntary and would not influence their course grade.

Upon instructors' approval, each class was visited at the end of the scheduled meeting time. I presented the purpose and importance of this research. At that time, I distributed and had participants read the informed consent form. The survey forms were then distributed to the students interested in participating. Survey administration process took approximately 10 minutes. Only the survey responses from participants who signed the consent forms were analyzed. The rationale was to select students with the highest anxiety scores. Those reporting the highest level of statistics anxiety in the survey were sent an email for interview set up. The final sample consisted of Natalie, Mandy, Brian, Kathy, Casey, and Jacky (pseudonyms were assigned to maintain participants' anonymity), and their anxiety scores were 30, 35, 28, 31, 31, and 37 out of 40 respectively. Although the survey was administered to all students in the five statistics classes, only the results from the students who chose to participate are used in the study.

Each participant was interviewed individually and spent approximately 50 minutes in a semi-structured, think-aloud; task-based interview. The interviews consisted of two distinct phases. During phase one, information was obtained about the specific situations inside and outside the classroom that participants believed trigger intense feelings of statistics anxiety. Participants also discussed the factors that they believed contribute to their heightened levels of statistics anxiety. Phase two consisted of two tasks. The first one was the statistical problem solving, whereas the second one was about statistical data interpretation. At the end of each task, the participants were asked to describe their feelings and thoughts. Finally, the

participants were asked to list the factors that they believed could alleviate their statistics anxiety.

All the interviews were conducted within a two-week period and were tape-recorded with the approval of the interviewees. Field notes were taken during the interviews. A memo documenting my coding experiences was kept throughout the process of data analysis. The recorded interviews were transcribed verbatim and then analyzed using thematic analysis (Patton, 2002).

Study Rigor

For the establishment of credibility (Lincoln & Guba, 1985), each participant was asked to check the accuracy of my interpretation of their responses. This served as a member check (Patton, 2002). For trustworthiness, the responses from all the data sources, that is, surveys, open-ended questions, and the interviews, were compared to check if the findings triangulated. In order to prepare future investigators to generalize findings in this study, as per Lincoln and Guba (1985), clear descriptions of the sampling and data collection procedures are included.

Findings

Situations That Trigger Statistics Anxiety

In response to the first question, three of the participants, Brian, Casey, and Jacky, noted that seeing a new formula or unfamiliar material causes them to feel anxious. Mandy and Kathy mentioned that they tend to be more anxious during exams because of the grade and time pressure. Natalie, on the other hand, noted that she feels anxious whenever she begins to solve a statistical problem because she is always scared her answer might be incorrect. Speaking in front of her teacher and classmates also results in increased statistics anxiety. The responses of all the participants in this study somewhat, if not completely, align with the findings of Williams' (2010) study. He concluded that students with statistics anxiety experience higher levels of discomfort than their peers in the following situations: (1) taking notes during class lectures, (2) taking tests, and (3) doing statistical computations.

Here, Natalie's summarization of situations that trigger her statistics anxiety levels is included:

When I am speaking in front of the crowds [teacher and classmates] that's when I get nervous. I don't wanna do it, and I find myself racing when I talk, just rambling on and my thoughts are very flustered. I guess it is just a fear that I could be wrong, and if I am wrong it is embarrassing to say the wrong answer in front of everybody

This is how Kathy feels when taking her test:

Probably the second I get the exam like handed to me [is when I feel anxious the most]. Quizzes I am not as anxious as with the exam[s] because they are worth more of a proportion of your grade in the class, and the second she hands it to me I start getting all scared and worried, and everything I have learnt kinda goes away right away.

Factors That Heighten Statistics Anxiety

The analysis of interview data of all the participants led to the emergence of four main themes: 1) inability to decode terminology and symbols, 2) feelings of inadequacy, 3) physiological symptoms, and 4) giving up. These four themes were common to all the six participants' responses when they were asked to discuss what they believe are the factors and situations that contribute to their statistics anxiety. Following is the detailed account of the themes or categories.

Inability to decode terminology and symbols. Throughout the interviews with the participants, one of the themes that emerged was their inability to decode statistical terminology and symbols. To Kathy, Jacky, and Casey, statistical formulas and symbols do not make any sense the first time they encounter them. Casey, for example, shared with me an instance when she had to miss her class. She became anxious and apprehensive that she would never be able to catch up:

The other day in class I was really sick with a head cold, so I missed Monday. On Wednesday the first thing she [the instructor] did was put up this huge, big equation on [the] board and I am, like, What? I have no idea what this is for. I don't know any of these numbers. I don't know what the letters are for. We were talking about this [for] the first time and I had no idea what it was.

During the interviews, I also discovered that these participants conceive statistical terminology and symbols as a foreign language. Kathy, for example, mentioned:

I've never been good with number, and the symbols [are] gibberish to me, unless I am told repetitiously over and over again. [It is] because I don't get it the first time, it takes me [a] second or third time to understand fully what each letter and so on means.

Feelings of inadequacy. Another theme that resonated throughout the interviews was feelings of inadequacy. The participants used the following terms to describe their feelings of inadequacy: *lack of confidence, incompetence, frustration, flustered thoughts, worry, intimidation, confusion, fear of the unknown, apprehension, panic, being overwhelmed, blank mind, and trouble focusing*. This theme of inadequacy echoes the findings of Blalock (1987) and Dillon (1982), who have established that statistics anxiety affects students' performance in statistics classes, and causes feelings of inadequacy and low self-efficacy for statistics-related activities.

On several occasions, Brian, Mandy, and Natalie, shared and provided detailed accounts of their experiences of feeling inadequate. For example, Brian mentioned:

In that class I've had a couple big blank outs, mostly when we were looking at some of the equations. I don't just see it as a step by step, at first I see it as a whole, and when I see it as a whole it is overwhelming and cause[s] me to be anxious about it so much so that I can actually blank out and completely forget anything, including the first step on how to solve the problem.

On the other hand, Natalie expressed her feelings associated with the lack of confidence with her answers on tests:

I feel very frustrated that I couldn't come to an answer that I feel confident about. I think the worst part is that I don't feel confident about my answer and that's what makes me very nervous.

Physiological symptoms. The third theme which echoed throughout the interview data was physiological symptoms. The participants used the following terms to express their physiological symptoms: *increased heart rate, shaking, the urge to cry, eyes watering, deep breathing, cheeks flushing, hot face, and stuttering*. This theme of physiological symptoms found is consistent with the findings of the research conducted by Onwuegbuzie et al. (1997). Their study was an in-depth qualitative exploration of statistics anxiety of 21 graduate students. They found students reporting psychological symptoms such as depression, frustration, panic, and worry, as well as physiological signs of headaches, muscle tension, perspiration, and “feeling sick.” The following quote describes Casey’s physiological symptoms:

I emotionally do not feel nervous but my body reacts anxiously, so I start shaking and my voice stutter[s] a couple times. I feel like I show it at the outside that I am nervous but inside I don't feel nervous, so I shake, and occasionally I stumble over my words, but I don't actually feel nervous.

This is how Mandy described to me her physiological symptoms:

Like on the last test, [while looking at the entire test to see the questions, I noticed] there were multiple-choice [questions on] one page. When I turned the page [I noticed that there were] three open-ended questions that I didn't understand. [I started] breathing deep and my eyes were watering. [So I started telling myself that] I can do this, I can do this, but when I still didn't get them and [they] didn't connect [because they looked unfamiliar], that's when I felt like crying because I didn't understand.

Giving up. The fourth and final theme that ran throughout the interview transcriptions was giving up. During the interviews, the participants used certain terms to express their feelings of giving up: *escape the moment, run out of the class, escaping, don't wanna do it, want to go away, end up skipping, give up on the test, stop trying, leaving out the problem blank, get up and leave the classroom, wanna leave, guesstimate, and second-guess*.

The participants, Casey, Mandy, and Jacky, mentioned explicit instances where they wanted to give up on a test they were taking or felt like running away from lectures when they were unable to understand the material. Casey, for example, shared with me an instance when she skipped a problem and ended up failing a quiz:

Most of my last quiz I remember there being a problem [that] I had to read over and over and over again. Then I read it one more time and I was, like, okay, now I know what I am looking for, but then I did not remember how to do [the problem], so I skipped it.

On the other hand, Brian, Kathy, and Natalie noted that they end up either second-guessing or leaving a statistical problem completely blank if they do not know how to attack it or if the material looks unfamiliar. Kathy discussed an example of her giving up on the first statistics exam:

My first exam in stats [class] while I was taking it [I realized that] I got the five-minute mark and I was only half way through that whole exam so I had five to ten questions still to go. [That is when I started] panicking so I just kind of guessed on three of them and two of them I didn't fill out. Then I just handed in my paper and I knew I didn't do well. It [was] one of the problems that I have always known even before I took the stats [course]. [That is why] I got so upset with myself because [I know] I blew it, but I was so time constrained that I just completely skipped the problem.

The above findings are similar to those in a study by Zbornik (2001) in which he noted that math anxious students restrict themselves to one area and aspect of the problem-solving field. Also, there is little attempt at trial-and-error learning or using alternative problem-solving approaches. These students often give up easily and skip problems that appear mildly difficult. They do not ask questions when stymied, but remain silent until others offer help. Since mathematics anxiety and statistics anxiety have been found to share some interesting parallels (Zeidner, 1991), the above findings about math-anxious students can be applied to stats-anxious students as well.

Factors That Reduce Statistics Anxiety

In response to the third question, participants mentioned: *taking tests in isolation, larger proportion of multiple choice questions on tests, more room to work out problems on exam sheets, formula sheet, open book, open notes, and visual cues (such as a diagram or a picture), and mantra.*

Additionally, most of the participants (Kathy, Mandy, Natalie, and Casey) agreed that they feel comforted if they are allowed to use a formula sheet during timed tests as well as taking tests with notes or book(s) open. These students also would like to take tests in isolation. Moreover, they requested that there should be more real world questions and visual representations of the questions so that they feel less anxious. Forte (1995) has already pushed for a solution to this problem by arguing for an effective teaching approach that incorporates computer usage, real-world applications, humor, statistical language practice, and group-learning principles.

The following quote by Kathy explains why she likes having multiple-choice questions on tests:

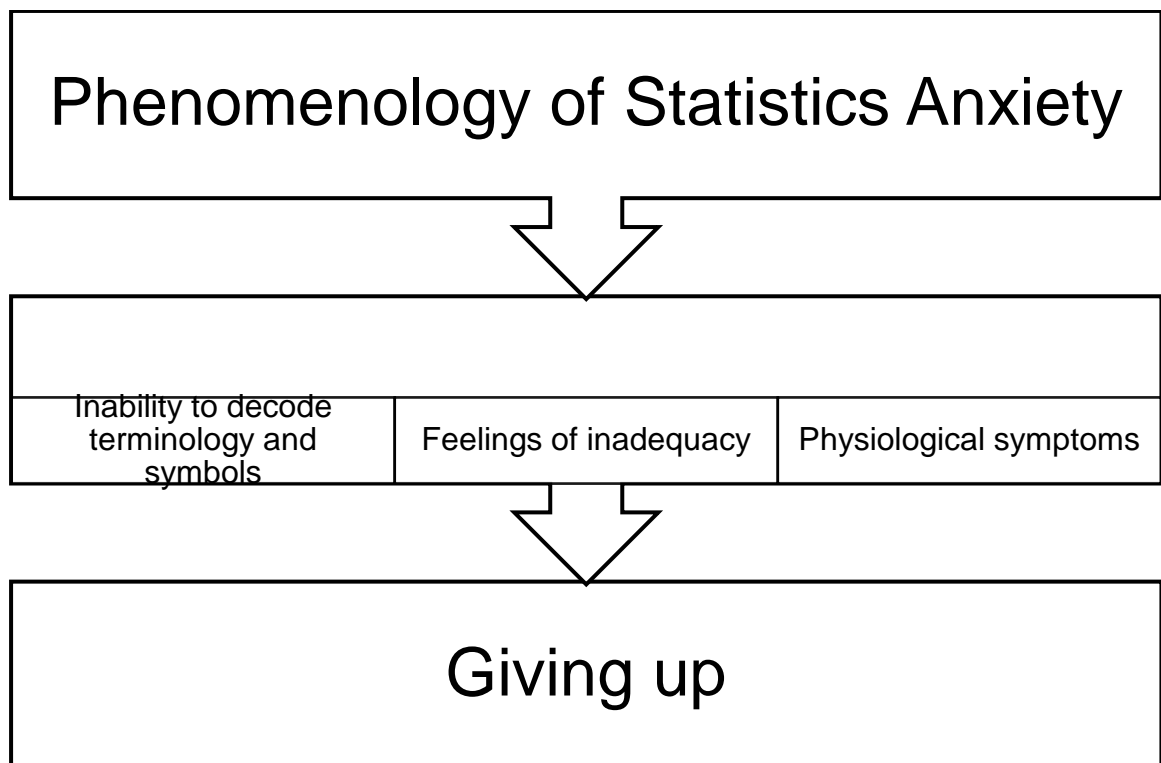
Because multiple choice is shorter, all you have is a, b, and c [to choose from]. You may have to write on the sides [for] some of the problems, but you have a 50-50 chance of getting [them] right and [you have the right answer in front of you]. It is more comforting to know [that] you have a 50-50 chance [of getting the right answer] and [that's why] multiple choice[s] can sometimes be easier.

Jacky finds her teacher's mantra "When eating an elephant take one bite at a time" to be helpful. This mantra comforts her when she sees a new formula, such as a correlation between two variables, in one piece or as a whole. This finding is consistent with that of Schacht and Stewart (1990) who found that students in statistics classes where humorous cartoon examples were incorporated felt reduced levels of anxiety. Additionally, Jacky finds physical exercises (brisk walking, biking, and working out on the elliptical machine) helpful in taking her mind off of her stressful situations that she encounters daily in the statistics classroom.

Model of Phenomenology of Statistics Anxiety

The phenomenology of statistics anxiety, based on all six participants' responses, can be stated as follows. Students with statistics anxiety encounter the following roadblocks while being in statistics class: (1) inability to decode terminology and symbols, (2) feelings of inadequacy, and (3) physiological symptoms. These roadblocks eventually cause students to (4) give up on graded activities as well as in class activities, including listening to class lectures and taking notes. The visual representation of how these four themes are linked together is given below in Figure 1.

Figure 1. The model of phenomenology of statistics anxiety



The overall model of phenomenology of statistics anxiety can best be summarized by Jacky's quote in which she shared her everyday challenges learning statistics:

I guess I get anxious the most when it is newly presented, and I haven't processed it yet. I carry that with me pretty much every day. I am a nontraditional student; it's been probably 20 years since I've been in school. Just that [I'll have to figure it out on my own] and thinking about it makes me pretty intimidated. [The apprehension that] I'm not gonna know what everybody is talking about [is frustrating]. I feel the same way when I'm taking test[s]. I can feel my blood pressure up, my cheeks flush, and if I get stuck [on a problem], I feel like in that particular situation I [wish I] could just leave the class.

Finally, the overall phenomenon of statistics anxiety based on the research questions and the categories that surfaced in this study has also been summarized in the form of a poem below, which is based on participants' interview responses.

Stats-Anxiety Poem

- I. *What is stats-anxiety?*
[Stats-] anxiety to me is a fight or flight response,
when your heart rate goes up and starts feeling the pressure,
Fight or flight, I guess that's the way I describe it and that's the only way.

- II. *Situation(s) that trigger intense feelings of stats-anxiety*
Probably the second I get the exam like handed to me,
for they are worth more of a proportion of my course grade.
The second she hands it to me I start getting all scared and worried, and
everything I have learnt kinda goes away right away.

- III. *Inability to decode terminology and symbols*
I think it is because I've never been good with numbers, and
the symbols, the Greek letters, and the statistical formulas are all gibberish to
me.
Unless I get it told repetitiously over and over again because I don't get it the
first time,
to understand fully what each letter and so on means; it takes me a second or
third time.

- IV. *Feelings of inadequacy*
Ever since I have been an undergraduate,
I've been feeling inadequate.
By inadequate I mean... not fully able to function in math,
to the level of a normal undergraduate.
I know other people struggle in my class but that's not enough to,
help me with the anxiety and everything else that comes with it.
It is definitely a time and grade pressure.
I sometimes feel worthless but not usually,
No, I do not think that I have low self-esteem,
But I just really feel like an idiot.

- V. *Physiological symptoms*
Whenever I have that panic attack,
in that situation my mind goes blank, and
I feel my heart racing.
Solving a statistical problem, on the other hand to me is,
really scary and nothing else.
I am scared of getting the problem wrong,
at that time it is about the only feeling.

- VI. *Giving up*
I spend more time on stats than any other class.
It is sort of irritating that I spend so much time.
I want to do well, and I am willing to spend that much time,
And when I can't figure out something,
I start crying because I couldn't figure it out,
I put the blame on the class and I feel like dropping.

VII. *Factors that reduce stats-anxiety*

*Having a formula sheet is very helpful,
and so is multiple-choice plus a take-home exam.
Having a visual makes it easier to process the information.
My instructor's different teaching methods and her willingness to help are
comforting.*

Discussion

Two of the participants noted that their high statistics anxiety levels were due to their negative experiences in the past while taking mathematics courses in high school or community college. Since mathematics and statistics are closely related fields (Onwuegbuzie et al., 1997), one can infer that a previous experience while taking a math course can lead to students' negative perceptions about statistics as well. On the other hand, two other participants held their high school teachers' rude comments and criticisms responsible for their higher statistics anxiety levels. These students also noted that their teachers were not available for them when they needed them the most. A similar point was raised by Williams' (2010) study. He identified instructors as having an important influence on the anxiety levels experienced by students. Because of this identification, he suggested that instructors show students genuine concern for their feelings as well as for their learning. Although the participants of this research identified several factors found to be related to a reduction in their statistics anxiety levels, the research about what teaching styles are beneficial in relieving anxiety levels is still unclear. In future studies, researchers could also consider exploring the influence of different learning styles and learning disabilities on the phenomenon of statistics anxiety.

Limitations

This study has several limitations that need to be identified: (a) I might have occasionally prompted the participants to give answers I was seeking instead of allowing them to provide unprompted responses; (b) five of the six participants were females, thus this study reflects mainly female experiences and perceptions of the phenomenon of statistics anxiety; (c) four of the six participants were psychology majors and including participants from other disciplines could have produced varied findings; (d) since this study was conducted in a liberal arts university with a predominantly white population, the results of this study will be transferable only to schools with similar demographics, and finally (e) one participant admitted to being dyslexic, so it may be learning disability that factors into this participant's heightened levels of statistics anxiety and this disability may not have been completely considered in this study.

Implications

This study has implications for teaching as well as for research. Separate classes should be offered to students having little mathematics background so that they can learn at a slower pace. Additionally, instructors should provide information regarding accommodating statistics anxious students, and not only physically disabled students, in their syllabi. Moreover, instructors need to adopt differentiated teaching strategies suiting the needs of all their students, including students with higher levels of statistics anxiety. For example, Brian requested:

[Teachers and educators should] make their lesson plans applicable from many different perspectives instead of just one, because if one might not work for some it might [work] for others and vice versa. The best general term is: know your students, know their capabilities, and push them to be their best but also understand that some of them might need that extra help or that new perspective of looking at the same problem, instead of saying, "Here is the material, if you don't get it you are screwed, kinda thing!"

Finally, instructors should be aware that students having a limited prior mathematics or statistics background might experience more difficulties in statistics courses, specifically when doing any sort of timed activity. Gundy et al. (2006) found web based instruction (WBI) techniques, such as Blackboard's digital drop box and online student discussion board, potentially useful tools to investigate students' statistics anxiety levels. They noted reductions in statistics anxiety in courses that required students to use WBI technologies via Blackboard (Blackboard Inc., 2001). Because of the findings of Gundy et al. (2006), incorporating supplementary conventional course instruction with WBI methods in introductory statistics classes is recommended.

Future researchers should consider including statistics majors and non-statistics majors as well as traditional and non-traditional students from various disciplines in order to explore the phenomenon of statistics anxiety more deeply. Also, in future studies, graduate students from different disciplines could be included as participants to broaden the understanding of the complexity of students' perceptions of statistics anxiety.

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